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The Basics of Monitor Technology

Preface

In recent years, the editing systems and equipment used by broadcasters, production houses and independent studios have improved dramatically, resulting in faster, smoother workflow, increased cost reductions, and simpler processes. With such systems and equipment, one person can function as the conventional director, switching operator, system engineer, and graphic designer. In the case of OB vehicles, additional requirements are a wider and more comfortable work space, lightweight equipment and lower power consumption.

As the systems, equipment and workflow get better, the quality of created video content meeting broadcasting needs must always be supported by accurate checking and evaluation of the final images and signals. The monitor has a critical role in this process. So has the operator, who needs a good knowledge of the various standards on broadcasting, signals and colors which the monitor should satisfy and of how to use these functions correctly.

In addition to conventional CRT TVs, new TVs using new flat display devices such as LCD TVs are spreading rapidly into the retail market. Video content creators must be aware that their work will be displayed on LCD TVs as well as the CRT TVs. LCD monitors are also quickly replacing CRT monitors in the the professional broadcasting industry. However, due to the differences between LCD and CRT technologies, the best use is not currently being made of either.

This document covers preparations before using the monitor, useful functions that the monitor must perform, and technical basics on the monitor such as the differences between CRT and LCD devices, broadcasting standards, signal standards and color reproduction standards.
Read the document through and keep it handy for reference when you choose a monitor to match your usage and environments, or conversely, when you change your environments to suit a CRT or LCD monitor, or when you first use a monitor, etc. This will help you to use your monitor appropriately and make the most of your monitor's performance in creating video content.

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Sony Monitor Lineup and Features

Sony supplies various monitor models in order to meet the requirements of applications used in broadcasting, video post production, instrumentation, and general industry.
This section gives an outline of each monitor series.
For the details, access http://www.sony.net.

BVM Series

A BVM-series monitor is a top-quality CRT monitor used mainly as a master monitor for broadcasters and production houses. Normally, each video editing system has one master monitor for performing technical picture evaluation, such as noise level checks, color accuracy, and black detail judgments, for evaluating created work. The BVM-series monitor is equipped with various functions to fulfill the mission of master monitor; consequently, the operator needs technical knowledge to manage these models.

PVM Series

A PVM-series monitor is a CRT monitor used mainly as a picture monitor for broadcasters and production houses. Normally, each video editing system would have several picture monitors to check input pictures. The PVM-series monitors are also widely used by companies and schools for image processing and laboratory work. Although the functions are limited compared with the BVM-series monitors, the easy-to-operate design is a feature of the PVM-series monitors.

LMD Series

An LMD-series monitor is the newcomer LCD (Liquid Crystal Display) technology used mainly as picture monitors or floor monitors by broadcasters and production houses. Their light-weight and slim design also make them suitable for use in outdoors and in OB vehicles. Normally, each video editing system or production system in an OB vehicle has several picture monitors to check video sources. The LMD-series monitors are also used by companies and schools for image processing and laboratory work. They are equivalent in functions to the PVM-series monitors. They also allow connection to a computer or measuring instrument with a computer output in order to meet the demand of new applications such as non-linear video editing.

Before Using the Monitor

To get the best performance from the monitor in picture and input-signal evaluation, perform the following adjustments and checks before using the monitor.

Checking the environments of the installation location of the monitor

Check the illumination, viewing distance, installation location, wall color, viewing angle, etc.

↓

Warming up the monitor

Turn on the power and wait until it is sufficiently warmed up (about 30 minutes).

↓

Adjusting the monitor

Adjust the white balance, chroma, phase, brightness, contrast, etc.

Checking the Environments of the Installation Location of the Monitor

The apparent color reproduction on the monitor is greatly affected by ambient light or glare.
This section introduces the ideal conditions of use for standard-definition (SD) CRT monitors for studio use meeting standards set by SMPTE.

Illumination

The ideal illumination conditions for a monitor are as follows:
– indirect lighting
– illumination with a color temperature near that of the reference white (D65 or D93, depending on the standard in your region/country)
– Maximum light around the monitor: 12 cd/m^2 (10% illumination of 120 cd/m^2 white [100 IRE] on a monitor)
– 30 to 40 lux reaching the operator
– 20 to 100 lux in client area or script reading area

Notes on the illumination environments for LCD and CRT monitors

The illumination environments greatly influence the reproduction of black, or the contrast, on LCD and CRT monitors.
Under a bright illumination, for example, in an office room which has about 500 to 2000 lux, the LCD monitor provides a higher contrast than the CRT monitor. Under a lower illumination, for example, in a studio, the CRT monitor has a higher quality than the LCD monitor.
The LCD device controls the brightness by moving LCD molecules with the backlight always lit. For this reason, in a dark place, an LCD monitor screen shows very dim light leaks from the black image. In a bright place, however, the LCD monitor is able to provide a high contrast thanks to its advantage of smaller light reflection.
On the other hand, the CRT monitor can cut off the black signal input and reproduce black even in a dark place. However, its contrast becomes lower in a bright place, as reflected outdoor light degrades the reproduction of black.

Viewing Distance

The ideal viewing distance is 4 to 6 times the vertical height of the monitor screen area.

Note on viewing distance for high-definition (HD) signals

When a high-definition (HD) signal is displayed on the monitor, the ideal viewing distance is 3 times the vertical height of the monitor screen area.

Installation Location

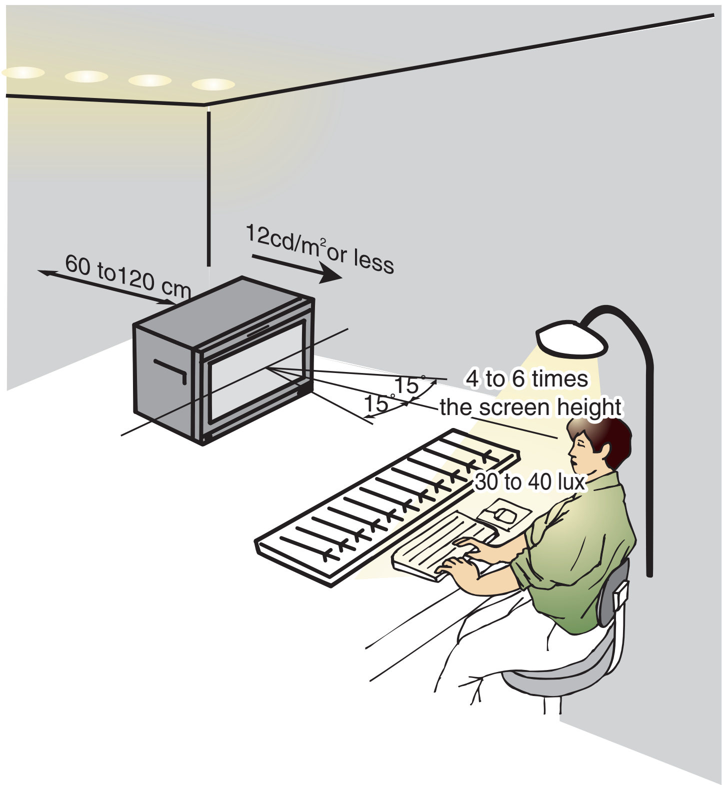
The ideal installation location is 60 to 120 cm (2 to 6 feet) away from the wall at the back of the monitor.

Wall Color

A neutral tint, especially neutral gray, is ideal for the wall color of the room where you install the monitor. The neutral gray area of more than 8 times the monitor screen area is needed.

Viewing Angle

The ideal viewing angle is within 5 degrees from the center of the monitor screen when the operator views the entire monitor screen. Keep the viewing angle within 15 degrees from the center of the monitor screen.


12cd/m²or less
60 to120 cm
4 to 6 times
the screen height
15°
15°
30 to 40 lux

Warming up the Monitor

To perform stable color reproduction, the monitor must be warmed up sufficiently.
Turn on the power of the monitor, display the white signal and leave it in this state for more than 30 minutes.

Adjusting the Monitor

The monitor is considered a measuring instrument and is required to faithfully reproduce the input signal. To measure the signal accurately, the decoder built into the monitor must be calibrated correctly using a reference signal.
Usually, color bars such as those specified by SMPTE are used for such calibration.

The required adjustment items may differ according to the type of monitor, CRT or LCD, and the functions it provides.

– LCD monitors

- White balance adjustment
- Chroma/phase adjustment
- Brightness adjustment
- Contrast adjustment

– CRT monitors

- White balance adjustment
- Chroma/phase adjustment
- Brightness adjustment
- Contrast adjustment
- CRT adjustments (uniformity, convergence, picture distortion, picture position, etc,)

White Balance Adjustment

On a color video monitor, white and black in a video image is reproduced by mixing red, green, and blue light. If the mixture rate is incorrect, for instance, the same white image may be seen reddish or bluish. The degree of tint is defined in terms of “color temperature.” D65 is normally used as a standard color temperature for color video monitors.
If a color video monitor has different color temperatures at the dark and bright parts of a black-and-white image, color cannot be reproduced correctly on that monitor. The white balance adjustment sets the color temperature throughout a black-and-white signal, regardless of its luminance (that is, in the dark and bright parts).
Because the white balance has already been adjusted at the factory, readjustment is not usually required when you use only one monitor. However, if you use multiple monitors side by side, fine adjustment is required to attain identical color temperature among the monitors.

Sony broadcast/professional CRT monitors are equipped with the beam current feedback circuit to maintain stable white balance for a long time.

Before adjusting

– When adjusting single monitor

- Prepare calibrated measuring instrument.
- Input the gray-scale signal from the reference signal source (signal generator) into the monitor to be adjusted.

If the monitor is not equipped with automatic white balance adjustment, use a color analyzer for white balance adjustment. As color analyzers may not be uniform in quality depending on the manufacturer or the product, if strict adjustments are required, we recommend that you calibrate the color analyzer periodically or before each adjustment or check the adjustment error of the color analyzer using a precision spectroradiometer, if necessary.

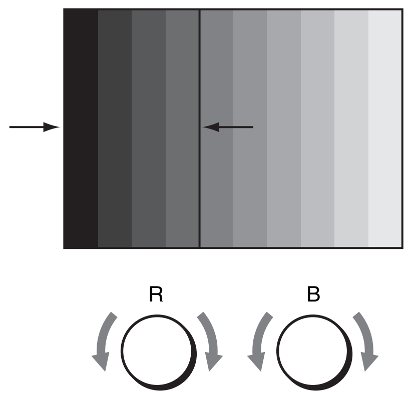
– When adjusting multiple monitors

- Prepare a reference monitor.
- Input the gray-scale signal from the reference signal source (signal generator) into the reference monitor and the monitors to be adjusted.
- Measure the reference monitor using a color analyzer and adjust the other monitors so that the same value as that on the reference monitor is obtained, using the following adjustment procedures.

Adjustment of the dark parts (Bias adjustment)

Color monitors are normally equipped with bias adjustment menus or bias adjustment holes for the R and B channels. Adjust each channel so that dark area of the gray scale (20% of the video signal input level) are seen the same as those on the reference monitor. Because the black area is heavily affected by ambient light, decrease the ambient illumination when performing the bias adjustment.

Bias adjustment

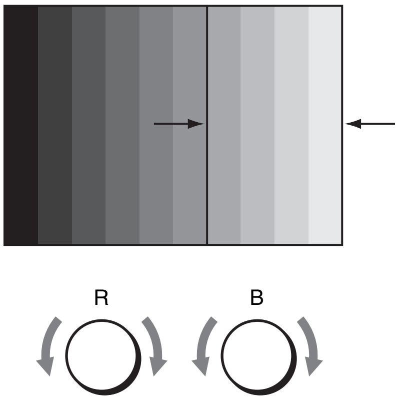


If these areas are reddish, decrease the red (R) level.
If the areas are weak in blue, increase the blue (B) level.

Adjustment of the bright parts (Gain adjustment)

Color monitors are normally equipped with gain adjustment menus or gain adjustment holes for the R and B channels. Adjust each channel so that the bright area of the gray scale (100% of the video signal input level) are seen the same as those on the reference monitor.

Gain adjustment



If these areas are reddish, decrease the red (R) level.
If the areas are weak in blue, increase the blue (B) level.

The bias and gain adjustments affect each other. Repeat the two adjustments until the darkest to the brightest part of the gray scale are seen the same as those on the reference monitor.

■ Decoder Adjustments

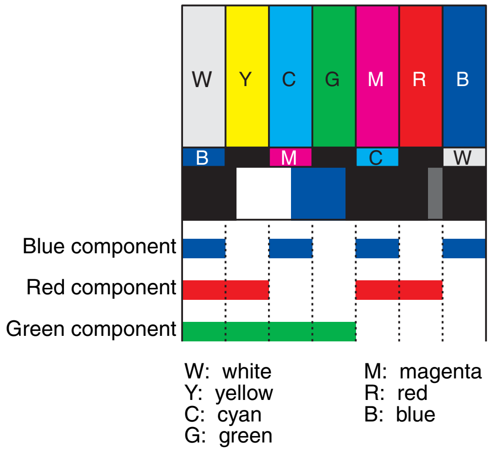
To display input composite video or Y/C signals on the monitor's screen, the signals are converted into RGB signals through a decoder. Therefore, the quality of the decoder and its adjustments markedly affect the monitor's quality of color reproduction.
Before using the monitor, adjust the decoder precisely using the reference signal. There are four decoder adjustments: chroma and phase adjustments, brightness (black level) setup and contrast (white level) setup.

The auto chroma/phase setup function on the monitor, if equipped, allows easier setup. Refer to the operating instructions of the monitor for use of the function. As the brightness and contrast cannot be adjusted with this function, adjust them manually.

CHROMA and PHASE adjustments

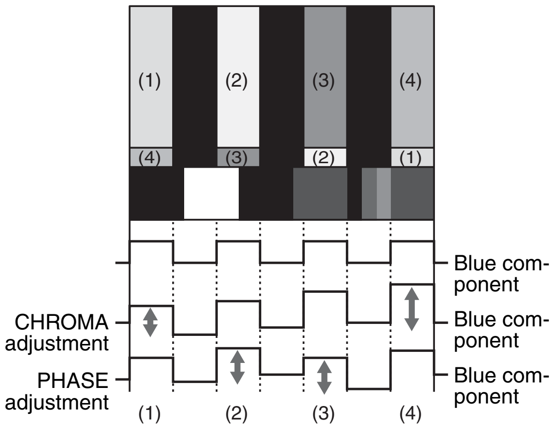
1 Input the SMPTE color-bar signal to the monitor.

SMPTE color bar



2 Set the monitor to the “Blue Only” mode.
The “Blue Only” mode displays the blue signal component only as a black-and-white signal. In order to make the adjustment of the decoder easier, the blue signal needs to be amplified. Sony monitors use a system of routing the blue signal to all three color channels. This provides the operator with a black and white display that is brighter and easier to see.

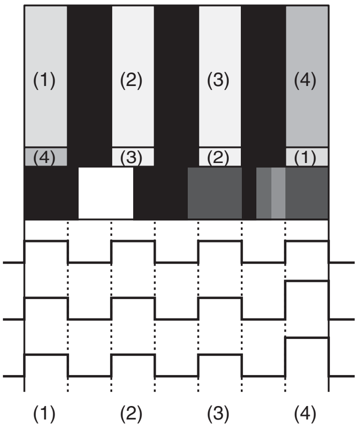
"Blue Only" display
Incorrect chroma and phase



If your monitor is not equipped with “Blue Only” mode, use a blue filter for the adjustments. Hold the blue filter in front of your dominant eye and look at the monitor's screen. Then, only the blue signal is seen, with red and green signals invisible. This is the same effect as “Blue Only” mode.

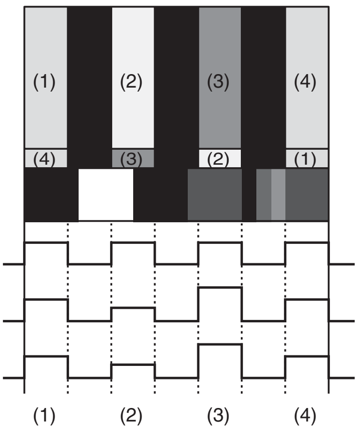
3 Adjust the CHROMA control so that the brightness of bars (1) and (4) are the same.
If you increase the level with the CHROMA control, the brightness increases in the order of bars (1) to (4). If you decrease the CHROMA level, the brightness decreases in the order of bars (1) to (4). Adjust the CHROMA control in practice until the upper and lower parts of bars (1) and (4) have the same brightness.

Incorrect chroma



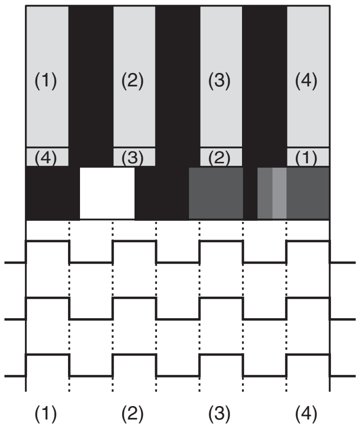
4 Adjust the PHASE control so that the brightnesses of bars (2) and (3) are the same. (This adjustment cannot be performed for PAL signals and component signals.)
Phase determines hue. If phase is incorrectly adjusted, the correct hue is not reproduced, because the ratio of color components included in each of the color bars is wrong. If it is correctly adjusted, cyan in bar (2), which is a mixture of green and blue, and magenta in bar (3), which is a mixture of red and blue, have the same amount of blue component. As you adjust the PHASE control, the blue component level changes symmetrically in bars (2) and (3). Adjust the PHASE control in practice until the upper and lower parts of bars (2) and (3) have the same brightness.

Incorrect phase



5 As the CHROMA and PHASE adjustments affect each other, repeat steps 3 and 4 until the brightnesses of all (1), (2), (3) and (4) of the color bar are the same.

Correct chroma and phase



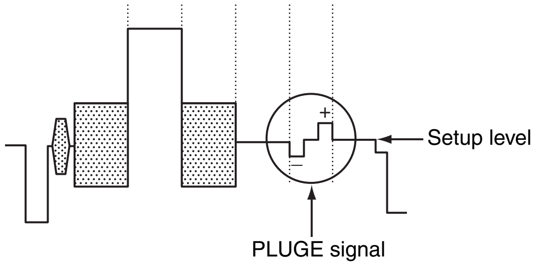
6 Release the “Blue Only” mode.

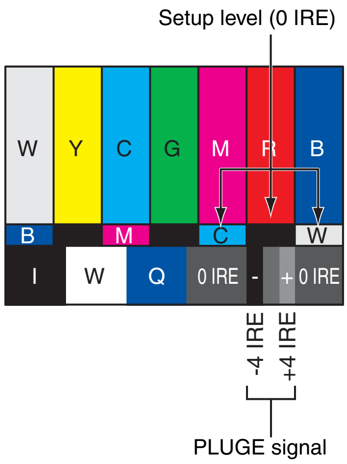
Brightness setup

It is common that a dark image, which cannot be seen in a bright room during the day, is clearly visible in a darker room or at night. This is because a dark image on a color video monitor is seen differently according to the ambient light (environmental brightness).
To deal with this phenomenon, adjust the black level of the video signal (brightness) on the monitor according to the ambient light and the black level of the image to be reproduced.

1 Input the SMPTE color-bar signal to the monitor.

2 Adjust the BRIGHTNESS control, observing the three black bars in the PLUGE signal section of the color bar.
The three bars show 0 IRE-black (luminance 0), a brighter black 4 IRE, and a darker black -4 IRE.
As you increase the level with the BRIGHTNESS control, the three bars are seen more distinctively. As you decrease the BRIGHTNESS level, -4 IRE bar is seen equal to the 0 IRE bar; thus only the 4 IRE bar lights very dimly. The monitor is now set up to display a 0-IRE signal as the darkest black.





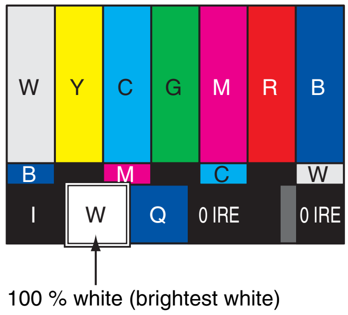
Readjust the brightness each time light conditions are changed.

Contrast setup

Contrast (white level) must be adjusted depending on the ambient light in the same way as brightness is set up.
For optimum viewing, higher contrast setup is recommended in a bright room, while lower contrast setup is more appropriate in a dark room. Set the maximum contrast as high as possible so that washed-out pictures are not seen. Washed-out pictures occur due to white compression, that is, the phenomenon of scan lines overlapping on a CRT monitor, and gray scale in the white portion is lost on an LCD monitor.

1 Input the SMPTE color-bar signal to the monitor.

2 Increase the contrast level with the CONTRAST control to the extent that the 100-IRE white (the brightest white) in the color bar is not a washed-out or blooming picture.
If the contrast is too high, washed-out pictures occur and degrade the resolution.



Readjust the contrast each time light conditions are changed.

■ CRT Monitor Adjustments

Master CRT monitors such as BVM-series monitors are equipped with fine-adjustment functions to improve color reproduction.
This section outlines of various adjustments. For details, refer to the operation manual supplied with the monitor.

Uniformity adjustment

The uniformity adjustment corrects to attain even color reproduction on every portion of the screen. Display an all-white signal on the monitor and adjust the uniformity to reproduce a flat and uniform white on every portion of the screen.

good bad

Convergence adjustment

The convergence adjustment exactly registers red, green, and blue lines to make a white line. If the three lines are shifted, color fringing may occur.
To adjust the convergence, display a cross-hatched pattern on the monitor; then, if the red, green and blue lines are not converged, move the shifted line up, down, left, or right so that they are completely white or "correctly converged."

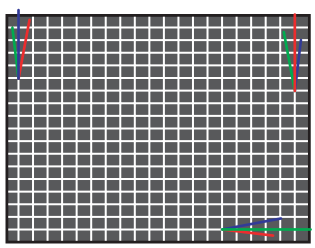


Image distortion correction

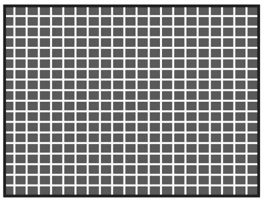
Display a cross-hatched pattern on the monitor and correct image distortion on the entire screen, such as linearity and pincushion distortion.

– Linearity

Correct uneven spaces between lines so that the lines are aligned with the same interval (or distance) and the same squares are equal in the center and peripheral areas of the screen.

– Pincushion

Correct curved lines to make straight, vertical, and horizontal lines.



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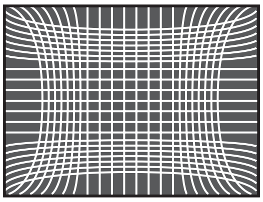

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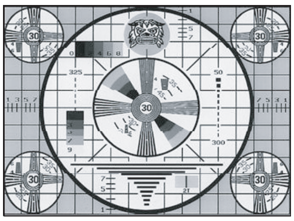
Picture position adjustment

Display a monoscope pattern on the monitor and adjust the position of the pattern.

Foucus adjustment

Adjust the focus so that the lion's face on the upper part of the monoscope pattern is clearly visible.



Tips on Using the Monitor

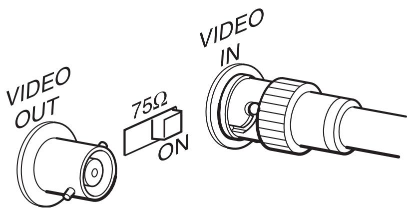
This section introduces useful operations of the monitor while you are editing videos.
After performing the adjustments and checks following “Before Using the Monitor,” read this section and operate the monitor as required.

When the Image is Blurred

Adjust the sharpness, using the aperture control.
Increase the sharpness and view the monitor image from a distance of 2 to 3 meters (7 to 19 feet). The image becomes clear. This function is useful when you evaluate the monitor.
Adjust the aperture control to decrease the sharpness if the edges of the image are too enhanced.

When the Image is too Bright or Dark

If 75-ohm termination is disabled, the image on the monitor is too bright and loses detail. Make sure that the termination is abled.



There are three termination methods depending on the unit.

1. 75-ohm termination connector: BVM-series monitors, measuring instruments
2. Termination switch equipped on the unit: VTR, etc.
3. Automatic termination: PVM-series monitors, LMD-series monitors

For method 1, connect the termination connector to the video output connector on the unit.
For method 2, set the termination switch to ON.
For method 3, check that a BNC connector is connected to the video output connector and the other end of the cable is free (case A), or a BNC-RCA plug adaptor is connected to the video output connector and no cable is connected to the adaptor (case B). In case A, disconnect the cable from the video output connector or connect the cable to other equipment. In case B, disconnect the plug adaptor or connect a cable to the plug adaptor and other equipment. If there is no case A or B, and nothing is connected to the video output connector, the termination section may be damaged. Ask for repair of the monitor, or connect a termination connector.

If the image is extremely dark, the automatic termination may not be deactivated even when a cable is plugged into the video output connector. This phenomenon tends to occur when the pins of the cable are damaged. Try to use a new cable for the connection.

When the Marker Glows

If a high marker level is set, and the luminance of the marker is too high, the marker glows.
Lower the luminance of the marker using an adjustment menu, such as “Marker Level” of the “User configuration” menu, etc. (The marker-level menu is not provided with some monitor models.)

When Black is Floating

The black setup level may be incorrect when an NTSC or 480/60I component signal is displayed.
Adjust the setup level as in the following table.

Area		Setup level
North America		7.5 IRE
South America	Argentina, Paraguay, Uruguay	0 IRE
	Other areas	7.5 IRE
Africa, Australia, Europe, the Middle East		0 IRE
Asia except Japan	NTSC area	7.5 IRE
	PAL area	0 IRE
Japan		0 IRE

Technical Basics

When someone looks at an object, he/she recognizes its color when the light reflected by the object passes through the retina and the stimulus reaches the brain. With this mechanism, we can recognize a wide range of colors.
On a camera or monitor, the input information of the light reflected by the object is separated into three primary colors (R, G, and B), which pass through mechanisms in the monitor to integrate, and finally are displayed as the object with its color and shape on the screen. The range of colors that the monitor expresses and communicates is limited compared with human color perception. The different mechanisms may make differences in colors among the colors the human brain can recognize, the colors developed within the system and the colors reproduced by a monitor.
This is the reason why many standards and regulations are defined regarding the television system and color reproduction on the monitor. Today, video content is created and edited by broadcasters and production houses all over the world, but they are checked and evaluated in accordance with the same standards.
This section introduces basic information on the standards and regulations, to help you make best use of the monitor.

Television Systems

To make compatible communication possible, there are two main television system groups regulating video information (three primary colors) in the world. Broadcasters all over the world deliver video content according to the following two television systems:

– NTSC system
Employed in North America, Central and South America, Japan, etc.

– PAL/SECAM system
Employed in Europe, Singapore, Hong Kong, Brazil (PAL-M), etc.

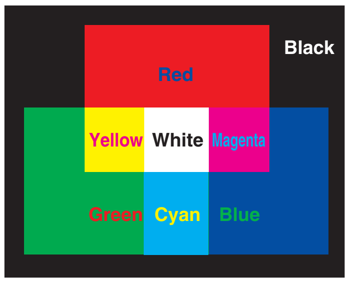
Each group defines the chromaticity of the three primary colors and the reference white as follows:

		NTSC		PAL/SECAM	
		x	y	x	y
Three primary colors	Red	0.67	0.33	0.64	0.33
	Green	0.21	0.71	0.29	0.60
	Blue	0.14	0.09	0.15	0.06
Reference white		0.310	0.316	0.313	0.329
		Standard source C		Standard source D65	

Color Reproduction in the Monitor

Three Primary Colors

If you enlarge a monitor screen, you can see red, green, and blue light emission. The monitor reproduces colors in combination of three color lights, the so-called "three primary colors."



Additive mixture of colors

Phosphor

The CRT (Cathode Ray Tube) is a device to express video information transmitted from areas in the world according to the television systems (NTSC, PAL) of the world. The surface of the CRT is coated with red, green and blue phosphors. When the electron beam emitted from the CRT hits a phosphor, light is emitted, and that color is produced on the monitor screen. The chromaticity of these phosphors for each primary color must strictly conform to the television system's standards (NTSC, PAL) and be compatible with the input video signal.

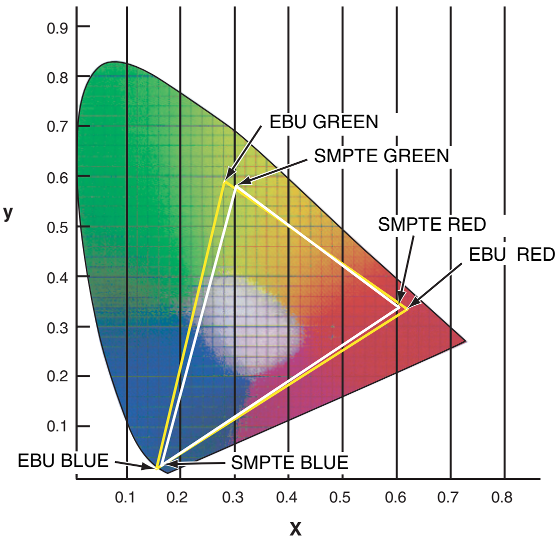
The following two standards are applied to the phosphors, based on the chromaticity points defined by CIE (Commission Internationale de l'Eclairage).

–EBU: Standard for phosphors determined by EBU (European Broadcasting Union), based on the CIE chromaticity points

The EBU standard is integrated with the three primary colors of the PAL system. The EBU standard is also employed as the standard for studio video monitors in Japan.

–SMPTE-C: Standard for phosphors determined by SMPTE (Society of Motion Picture and Television Engineers), based on the CIE chromaticity points

The SMPTE-C standard is determined as the official standard for studio video monitors by SMPTE. The chromaticity points of phosphors are based on those employed by Conrack Co. in North America, because the theoretical three primary colors of the NTSC television system employed in North America and Japan cannot be reproduced on CRTs. Every Sony professional/business-use monitor uses a CRT that satisfies the EBU or SMPTE-C standard. (As an exception, there are some low-price models whose CRTs are corresponding to these standards [with a wider tolerance range] or employ unique phosphors).



CIE chromaticity diagram

Chromaticity for high-definition system

The chromaticity of the three primary colors and the reference white for the high-definition system are defined by ITU-R BT. 709 as follows:

		ITU-R BT.709	
		X	Y
Three primary colors	Red	0.64	0.33
	Green	0.30	0.60
	Blue	0.15	0.06
Reference white		0.313	0.329
		Standard source D65	

LCD (Liquid Crystal Display)

The Sony LMD-series monitors use LCD instead of CRT display.

Previously, LCD monitors were considered unsuitable as professional monitors, since strict accurate color reproduction is required for professional applications.

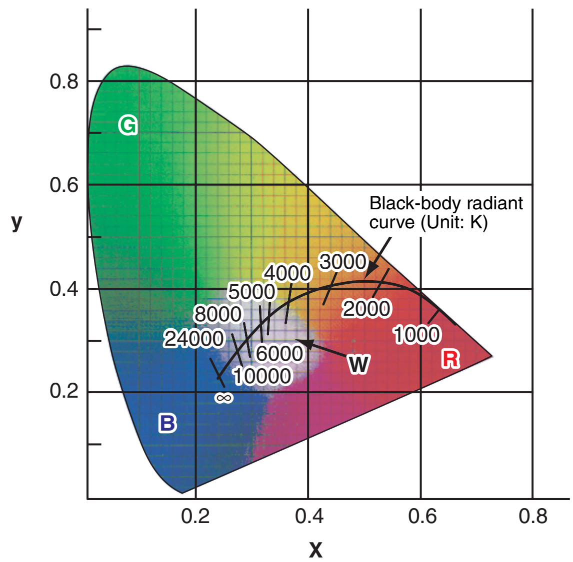
The use of high-luminance and high-contrast LCD panels with newly developed color filters offering excellent color reproduction affords the LMD-series monitors quality and accuracy close to CRT monitors, although the tolerance range is wider than the CRT monitors. (Some lower-price models employ LCD panels with a limited color gamut and a narrower viewing angle to meet their applications.)

■ Color Temperature

The color of an object we usually see is called "object color." It is the color of the light reflected from the object illuminated by a light source. In contrast, the color of light that a light source emits itself is called "light color." A color of the image on a monitor is light color. The chromaticity of a light source is represented in units of kelvins for the physical quality "color temperature."

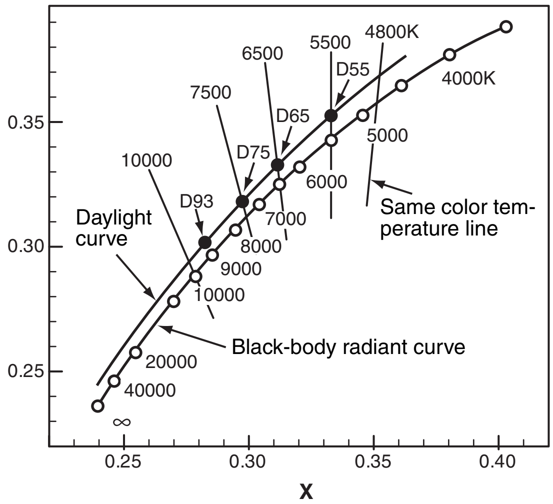
The color temperature is defined by heating a black body element such as carbon or tungsten (black body absorbing all radiation without transmission or reflection). When a black body is heated, it will start emitting light when it reaches a certain absolute temperature (expressed in K [kelvins]). This is called color temperature. The higher the color temperature, the more bluish the object light; the lower the color temperature, the more reddish the object light.

The chart below shows the chromaticity of a black-body radiant curve.



Black-body radiant curve on the CIE chart

In reality, we live in environments under sunlight. The color temperature under sunlight is slightly different from the black body radiation. For this reason, the daylight curve is made by tracing color temperatures of a standard light source artificially imitating sunlight. D in standard source D65, for example, means daylight.



Daylight curve and black-body radiant curve

Standard light sources defined by CIE

– Standard source A
This is color temperature of light emitted from a tungsten lamp of 2856K. The color is equal to the light emitted from a black body of the same temperature.

– Standard source B
Black-body radiant 4874 K, or light close to average sunlight at noon.

– Standard source C
Black-body radiant 6774 K, or light close to average daylight.

– Standard source D65
This is color temperature of 6504 K (not present in a black-body radiant curve). This light is considered closest to actual ambient light, including daylight and ultraviolet rays.
PAL/SECAM reference white.
Reference white in the standard for studio monitors in both the NTSC and PAL/SECAM areas.
The white balance of a video monitor must be adjusted to this color.
Popular color temperature used all over the world.

– Standard source D55
This is color temperature of 5503 K (not present in a black-body radiant curve) .
The color of sunlight with sky-tones added.

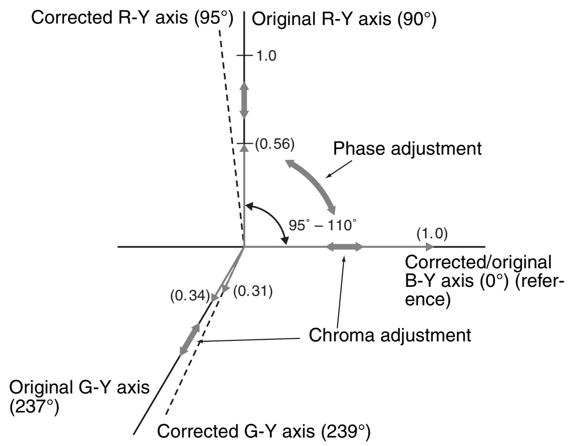
– Standard source D75
This is color temperature of 7504 K (not present in a black-body radiant curve).
The color is defined as sky-tones in northern countries.

– Standard source D93
This is color temperature of 9305 K (not present in a black-body radiant curve).
The standard reference white for studio monitors in Japan.

Decoder Characteristics

To reproduce the input RGB signals accurately in the NTSC system, B-Y and R-Y signals must be decoded with a phase of 90 degrees. While the decoding axis of professional monitors is set exactly to 90 degrees, that of consumer TVs is set to 110 degrees in order to reproduce bright skin tones. Further, the decoding axis setting of consumer TVs differs depending on the manufacturer. Consequently, accurate color reproduction cannot be obtained with consumer TVs even if you perform the chroma and phase adjustments .

Corrected decoding axis and amplitude correction ratio (B-Y axis as reference)



Video Signal Standards

This section introduces the features of various video signals that can be input to monitors.

Analog RGB Signal

The RGB signal is a source signal. It provides the highest-quality video signal, but has too great a volume of information to be recorded or transmitted.

Component Signal

The video quality is close that with an RGB signal. It is separated into a luminance (Y) signal and color-difference signals (R-Y and B-Y), and is capable of high recording quality while maintaining excellent color reproduction and color resolution.

Y/C Signal

It is separated into a luminance (Y) signal and chrominance signal (C), and it eliminates subcarrier leakage and cross color artifacts caused by the interference between the two signals. The disadvantages are shorter transmission distance and the need for a public-use 4-pin mini DIN connector whose pins tend to break.

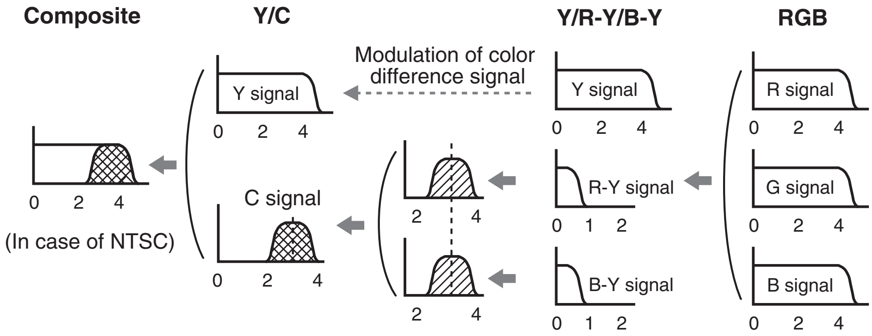
Composite Signal

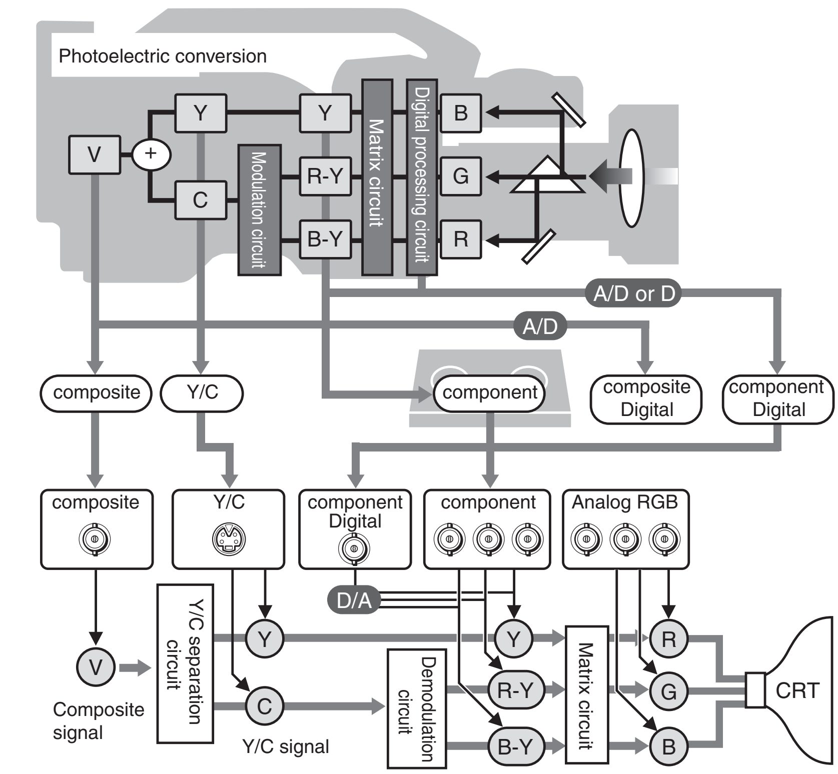
The composite signal includes the luminance signal (Y) and chrominance signal (C) to form one signal. This is most popular video signal. It can be transmitted over a long distance using only one cable and allows long recording time.

SDI/HD-SDI Signal

The SDI signal is a component digital signal conforming to the SMPTE259M/ITU-R BT.656 (CCIR656-III) Serial Digital Interface (SDI) standards, and the HD-SDI signal is that conforming to the SMPTE292M High Definition Serial Digital Interface (HD-SDI) standards. It is the digital form of the component signal.

The SDI signal enables transmission of high-quality video and audio via a single coaxial cable. It is popular with broadcasters and production houses, because it is not affected by noise interference as compared with analog signals.

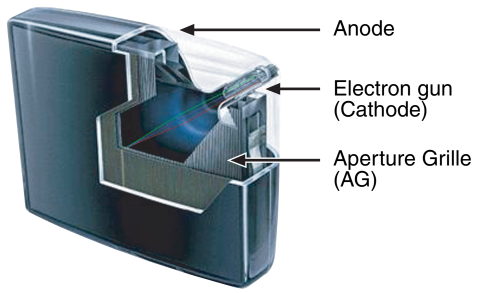

Composite
Y/C
Y/R-Y/B-Y
RGB
Modulation of color difference signal
Y signal
C signal
R-Y signal
B-Y signal
R signal
G signal
B signal
(In case of NTSC)


Photoelectric conversion
Modulation circuit
Matrix circuit
Digital processing circuit
A/D or D
A/D
composite
Y/C
component
composite Digital
component Digital
Analog RGB
D/A
Y/C separation circuit
Composite signal
Y/C signal
Demodulation circuit
Matrix circuit
CRT

Devices Used in Monitors

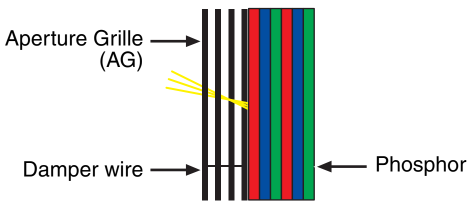
CRT

A CRT (Cathode Ray Tube) is a device used in the BVM and PVM series monitors.
When the cathode is heated, electrons are emitted and attracted to the anode by high voltage supplied to the last grid. Colors are produced when the accelerated electrons hit the RGB phosphors. To reproduce an image accurately on the surface with the RGB phosphors, an electronic lens and color-separating mechanism are present in the CRT gun. A deflection yoke is used to scan the electron beams across the CRT picture area.



Vertical linear face

There are two types of color-separating mechanisms: Trinitron and Shadow Mask. Trinitron employs a blind-type Aperture Grille (AG), and Shadow Mask employs a lattice-type mechanism which looks like small holes.
The Aperture Grille has a very fine damper wire to absorb any horizontal vibration due to its very fine diameter.



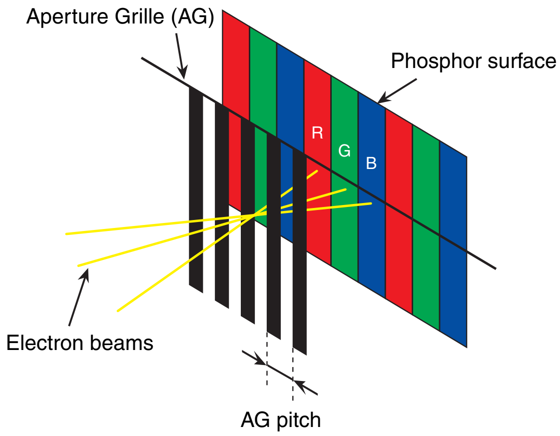
Trinitron

– Advantages of Trinitron compared with Shadow Mask
- Low ambient light reflection in the vertical directions
- Good linearity in the vertical directions
- High brightness and contrast
- Less doming caused by the expansion of the color-separating mechanism under increased heat

In recent years, thanks to the progress in glass design and electron-gun technology, both types have achieved a flat screen for TV and computer display. From a standpoint of doming, however, Trinitron still has an advantage.

About the AG pitch

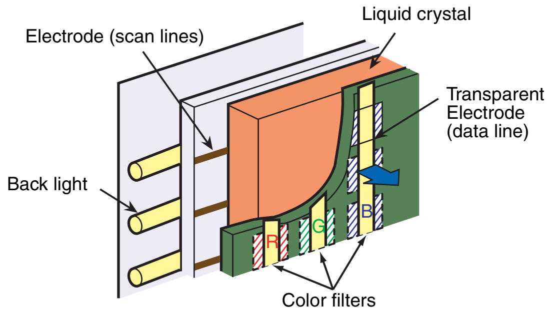
In the Trinitron CRT, electron beams pass through slots of the Aperture Grille and hit phosphor stripes organized as red, green, and blue. The distance between slots of the Aperture Grille is called AG pitch, expressed in units of millimeters, The finer the AG pitch, the more detailed the image and the higher the resolution. The advantage is that due to its structure, it can easily expand with heat, eliminating purity problems.

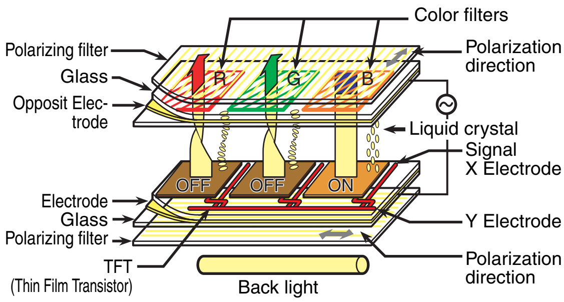


LCD

LCD (Liquid Crystal Display) is a device used in our LMD series monitors.
In order to explain the basic structure and theory of the LCD, the following introduces the technologies of a TN (Twisted Nematic) LCD device which is employed in low-priced LMD-series monitors.

On a TN LCD, two polarizing filters positioned adjacent to each other at an angle of 90 degrees sandwich the liquid crystal material. When liquid crystal is rotated perpendicular to the polarizing filters, the light passes through the first polarizing filter and is interrupted by the second polarizing filter. By applying a voltage potential across the liquid crystal, the crystal's molecules orient perpendicular to the electric field, that is, in line with the polarizing filters. This allows the light to pass through both filters. The light-transmission rate is controlled by changing the voltage potential and thus the orientation angle of the liquid crystal's molecules.
Unlike a CRT, LCD is a display with fixed picture elements, and high-speed control of the picture elements is needed. For this purpose, TFT (Thin Film Transistor) is mounted to each pixel. Because the mounting of TFT requires high-precision processing technology, its productivity was low and large-sizing of screens was nearly impossible.   In recent years, however, the LCD industry has become prosperous and technological innovation has remarkably progressed, promoting rapid large-sizing of screen. The newly-developed technology also improves the viewing angle, previously an inherent disadvantage of the LCD monitor caused by the change in screen brightness or color reversing because of the LCD material structure.
The LMD-series monitors use appropriate technologies according to usage, required specifications, price, etc.





Evaluation Points for CRT Monitors

The evaluation points of the image quality of broadcast/professional CRT monitors are the following:

- Color gamut and accuracy
- Uniformity
- Purity
- Convergence
- Linearity
- Stability of high voltage circuit
- Horizontal resolution

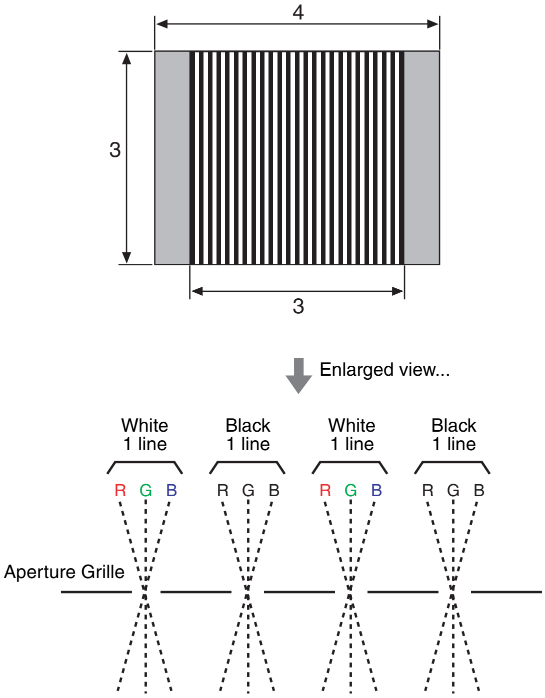
Conventionally, horizontal resolution has been an important point for evaluating the general picture quality of broadcast/professional CRT monitors.
This is because horizontal resolution can simply represent the picture reproduction quality of a CRT by a numerical value, although the quality depends on multiple factors in product design and manufacturing, such as the pitch difference of the color-separating mechanism, focus characteristic, interlaced scanning accuracy and circuit characteristics.

Horizontal resolution is measured by eye, by inputting the resolution chart in the still-picture mode into a monitor. As the CRT monitor has a superior response speed, it is known by experience that the horizontal resolution for a still picture can also be used as an index for evaluating the quality of motion pictures.

Here we introduce horizontal resolution and vertical resolution as evaluation points for broadcast/professional CRT monitors.

Horizontal Resolution

Horizontal resolution is defined by the number of TV lines that exist within an area where the screen width is the same as screen height. A theoretical value of the horizontal resolution for the Trinitron monitor is the number of slots of the aperture grille (75% the width of the monitor screen). However, the actual horizontal resolution value is not uniform, because of the frequency-response characteristics of circuits, beam-spot size, and other factors.

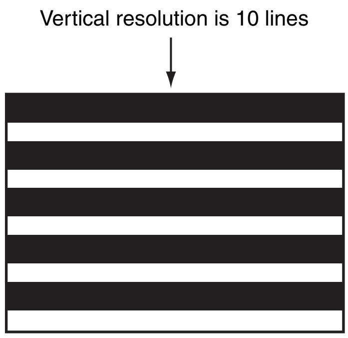


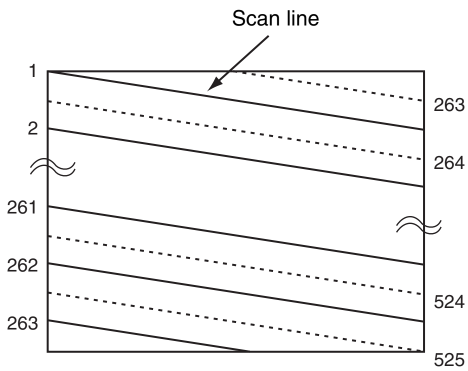
Vertical Resolution

Vertical resolution is the capability of a monitor to accurately reproduce horizontal stripes in the video signal. Vertical resolution is determined solely by the scanning system.
Vertical resolution is calculated as follows:

If the number of scan lines is 525 in the NTSC system, then the number of scan lines within the effective area is 483. Calculating the relationship between the scan lines and horizontal stripes according to statistics,
483 × approximately 0.7 = approximately 340 (lines)
yields the vertical resolution.

Vertical resolution does not differ greatly depending on the performance of the monitor, but its value may decrease owing to interlace ratio and focus characteristics. To maintain high vertical resolution, Sony monitors employ efficient circuits and CRTs.





Evaluation Points for LCD Monitors

The evaluation points of the image quality of broadcast/professional LCD monitors are the following:

– Horizontal resolution
– Resolution
– Viewing angle
– Contrast ratio and luminance
– Color gamut
– Gray scale and gamma curve
– Response speed
– Interlace/Progressive (I/P) conversion
– Video frame delay

Horizontal Resolution

Unlike a CRT, an LCD has fixed picture elements and the maximum resolution is determined by the number of picture elements. In addition, the changing speed of crystal molecules may differ greatly or the interlace/progressive conversion method may differ between the still image and the motion picture depending on the LCD product. For these reasons, horizontal resolution measured by the still image chart is not always reliable for motion picture quality, even if the LCD has the same number of picture elements.
Although, for a CRT monitor, horizontal resolution for the still image can be used as the index for the motion picture quality, the quality of an LCD monitor must be judged accurately and generally, not only with the horizontal resolution value (TV lines) described in the specifications in the catalog and the evaluation for the still image, but also with the evaluation of actual motion picture display.
When you compare an LCD monitor with another LCD monitor or with a CRT monitor, it is advisable to consider your installation environments and other factors as well as the horizontal resolution.

Resolution

Resolution is defined by the horizontal and vertical numbers of picture elements. In case of a computer signal, the maximum image quality is usually obtained when the number of picture elements of an image is the same as those of the LCD. In case of a video signal, however, the resolution sensed by eye may not accord with the actual number of picture elements. This is because the resolution is greatly influenced by the characteristics of the signal processing circuit, such as the relation between the resolution of the input signal and that of the LCD, the input signal quality, the interlace/progressive conversion, the scaling, etc. The resolution sensed by eye is also influenced by the installation environments of the LCD monitor, luminance of the LCD panel, contrast, response speed, etc.

Viewing Angle

For monitor specifications, viewing angle is defined as the angle within which the contrast ratio is higher than 10:1, both horizontally and vertically.

When you can see the monitor to evaluate, it is advisable to observe the change in contrast not only from the front but also from the sides and various angles. Even if the contrast is good when you see the image from the front, it may decrease greatly if you move away from the front.

The viewing angle evaluation by eye is also influenced by ambient light conditions. It is advisable to evaluate the contrast under both a bright light and a dark light.

Contrast Ratio and Luminance

For monitor specifications, contrast ratio is defined as the value obtained when the luminance of black is divided by the luminance of white. The LCD has a high contrast in bright environments because the back light is always lit and the reflection of outer light is reduced.

If the color filters are thin and coated with reduced colors, the color gamut becomes narrower but a higher luminance is obtained. If the monitor is optically designed so that the diagonal contrast is reduced and the back light focuses on the front of the monitor, the luminance seen from the front is high but the contrast in actual use decreases greatly if you move from the front of the monitor, resulting in an impression of a narrower viewing angle. Luminance also greatly influences the duration of the back light.

In a dark room, you may feel that the contrast on the monitor with a lower contrast value in its specifications is higher than that on the monitor with a higher contrast and luminance values. This is because the former monitor has a lower black luminance value than the latter.

	Maximum luminance	Contrast ratio	Black luminance
Monitor A	330 cd/m^2	380 : 1	0.87 cd/m^2
Monitor B	200 cd/m^2	300 : 1	0.67 cd/m^2

Color Gamut

As the color gamut is usually not announced officially, it must be checked by eye or using a color analyzer. The color gamut is determined mainly by the optical design of color filters and back light, but it is said that the manufacturing quality of LCD monitors is not uniform compared with that of CRT monitors. As mentioned before, color gamut has a close relationship with luminance.

Gray Scale and Gamma Curve

The specifications of gray scale and gamma curve are rarely announced officially. Mainly a 6-bit or 8-bit driver is used for the LCD. The gamma curve of some LCD devices has S-type characteristics. To evaluate the gamma curve and the gray scale, output the gray scale chart.

Response Speed

For monitor specifications, the response ratio is normally defined by adding the time elapsed when the color on the monitor screen changes from black to white at room temperature and the time elapsed when it changes from white to black. It is advisable that you confirm the definition of the specification because some monitors show their response speed as either the time elapsed when the color on the monitor screen changes from black to white or the time elapsed when it changes from white to black.

Further, some LCD devices have characteristics of a slower response ratio in the middle stage of gray scale, that is, between black and dark gray, or between white and light gray.

In conclusion, it is advisable to check the response speed of motion pictures by eye. The response speed decreases as the temperature lowers. The response speed may affect the actual video production and editing, for example, delay of video frames.

Interlace/Progressive (I/P) Conversion

Check the interlace/progressive conversion carefully, as there are different methods.

Jaggy noises and diagonal line flicker noises may occur depending on the method of interlace/progressive conversion. Some methods have different systems for processing of still images and for motion pictures, in order to achieve the appropriate processing independently. Some methods may cause a delay in image display to the input signal.

Video Frame Delay

Video frame delay is affected by the response speed of the LCD and signal processing by I/P conversion. As the monitor specifications sometimes indicate delay by signal processing only, you also need to consider the delay by the response speed of the LCD.

Terminology

A

aperture control
A circuit that applies edge enhancement or edge correction to a video signal. Electrically generated edge-enhancement signals ("preshoot" at the leading edge and "overshoot" at the trailing edge) are added to the original video signal for edge enhancement. Too much enhancement may result in a "blooming" picture. Enhancement also reduces picture resolution.

B

beam current feedback circuit
A circuit that stabilizes the color balance of a CRT monitor. Long-term charges in the electron gun of the CRTs used in color video monitors can result in an imbalance among R, G, and B, which causes a shift in the color balance of the display. This phenomenon is corrected by the beam-current feedback circuit, which detects the cathode current of the gun and maintains a table of balance data for a long time to be referenced for automatically adjusting the CRT drive circuits. This technology was first developed for the Sony BVM series broadcast monitors. It can be seen at the top of the raster just above the picture as Red, Green and Blue horizontal lines.

black-and-white TV standards
There are two standards for black-and-white video signals: CCIR and EIA.
The CCIR system is the European standard, having 625 horizontal scan lines. The EIA system is the American standard, having 525 horizontal scan lines. The differences in specifications are shown in the table below.

System	CCIR	EIA
Scan lines	625	525
Horizontal scanning frequency	15.625 kHz	15.75 kHz
Vertical scanning frequency	50 Hz	60 Hz
Interlace	2:1	2:1
Compatible color system	PAL, SECAM	NTSC
Developing country	France	U.S.A.

blue only
A function to show only the blue color component of a displayed signal. This function is used to adjust the decoder of a color video monitor (CHROMA and PHASE) and to check for noise on signals using a color-bar signal. Some monitors show only the blue signal component on display. However, most Sony color video monitors show the blue signal as a black-and-white display providing a bright screen to facilitate adjustment. Both types have the same function.

brightness (black-level) setup
The level of the black signal that functions as the reference level for video signals. In North America, 7.5 IRE is specified as the setup level and 0 IRE in other areas. If a monitor is not adjusted to match the setup level of the input video signal, the displayed image becomes to dark or too light.

C

CCIR
Abbreviation for Comite Consultatif International des Radio-Communications. CCIR has been merged with ITU and is currently called ITU-R.

CIE
Abbreviation for Commission Internationale de l'Eclairage

color bars
A reference signal to be used for checking the color reproduction of color video monitors and VTRs. There are seven vertical color bars: a white bar on the very left followed by six colored bars to the right. These color bars are in descending order of each color's luminance value. A full-field color-bar signal, split color-bar signal, SMPTE color-bar signal are used.

comb filter
A filter which can separate the luminance (Y) and chrominance (C) components of video signals with high accuracy using the correlation characteristics among other scan lines. It does not allow deterioration of horizontal resolution, unlike trap filters. A two-line comb filter uses the correlation of the scan lines; thus, vertical resolution decreases, and dot noise along the horizontal lines appears when reproducing horizontal stripes.
This shortcoming is improved by a three-line comb filter, which uses an image of two horizontal scan lines (those before and after the present scan line). A more sophisticated three-dimensional comb filter, which not only utilizes the correlation among scan lines but also fields, is also available.

cross color
A phenomenon that causes a rainbow effect to appear on a specific image, such as a shirt with a striped pattern. This is caused by crosstalk when the Y- signal component is present in the C signal because of incomplete Y/C separation.

CRT (Cathode Ray Tube)
A device to reproduce images by emitting electron beams generated by a high voltage circuit though a vacuum glass tube and hitting color phosphors.

D

degauss
To remove magnetism from a CRT. Magnetic materials, such as the aperture grille of a Trinitron CRT, can become magnetized, causing color-purity errors on the display. A degaussing coil is positioned around the CRT, and a current flows through this coil when the monitor's power is switched on, demagnetizing the CRT. Professional color video monitors also have manual degauss switches.

dot interference
A dot-shaped interference signal occurring at edges and boundaries of colors. It is also called cross luminance. If the Y and C signals are not separated completely, or if there is no correlation between the images of neighboring scanning lines, the interference is caused by residual chroma signals in the luminance signal.

E

EBU
Abbreviation for European Broadcasting Union

ENG
Abbreviation for Electronic News Gathering
Location news shooting using TV cameras and VTRs

H

horizontal resolution
A monitor capability to reproduce details of an input signal can be described in terms of resolution. This term is defined in units such as TV lines. The higher the number of such units, the finer the detail of video images that can be displayed. The number of vertical white-and-black stripes that can be discerned within an area where the screen width is the same as screen height (a screen of 3:3 aspect ratio) is the horizontal resolution. Horizontal resolution is determined by the aperture grille (AG) or shadow mask pitch, the frequency- response characteristics of circuits, beam spot size, and other factors. In the professional video industry, horizontal resolution is judged visually using a monoscope pattern. In consumer models, horizontal resolution is calculated mathematically from the frequency-response characteristics, and thus tends to be given a higher value.
Vertical resolution is determined solely by the color system. It is not affected by the performance of the CRT and internal circuits as horizontal resolutions.

H/V delay
A function that checks the sync signal, burst signal, etc., in the blanking interval of a video signal. Horizontal delay and vertical delay can be controlled separately on some monitors. To monitor the sync signal that is normally darker than the reference black, the H/V delay function brightens the screen and consequently the normal video portion is seen floated. Synonymous with pulse-cross.

I

interlace/non-interlace (progressive)
Interlace and non-interlace are two types of scanning.
To reduce the flicker phenomenon, television systems use interlace scanning. In interlace mode, the first scan creates every other line (first field) while the next scan creates the remaining lines in between (second field). One frame, a complete picture, consists of these two fields so that flicker phenomenon is reduced. In non-interlace mode, complete scans are performed in order from the top to the bottom of the screen.
The NTSC system defines one frame with 525 TV lines, and 30 frames per second. The PAL/SECAM system defines one frame with 625 TV lines, and 25 frames per second. There are multiple standards for higg-definition signals.

IRE
Abbreviation for The Institute of Radio Engineers

IRE unit
In NTSC format, an IRE unit represents the voltage level of the video signal and that of the sync signal level in a proportion of 10:4. The video signal is expressed by 0 to 100, and the sync signal by 0 to 40,
In PAL/SECAM format, the voltage level of the video signal and that of the sync signal is represented in a proportion of 7:3, and with a unit of millivolt.

ITU
Abbreviation for International Telecommunication Union

ITU-R
Abbreviation for International Telecommunication Union-Radio

I/P (Interlace/Progressive) conversion
An LCD device without the scanning mechanism of electron beams displays all picture elements simultaneously on the screen using the TFT (progressive display). The I/P conversion converts the interlaced signal into progressive.

L

landing and convergence
Landing indicates if the R, G and B electron beams respectively land precisely on the R, G, and B phosphors. Convergence is an indication of how accurately the electrons are passing through the aperture grille (or shadow mask) and meeting on the CRT's face plate.

LCD (Liquid Crystal Display)

A device to display images by controlling the light emitted from the back light through the liquid crystal molecules sandwiched by two polarizing filters and changing its transmittance.

N

NTSC

Abbreviation for National Television System Committee
NTSC is a color TV broadcasting system adopted mainly in North American countries, and in parts of Asia and Central and South America.

P

PAL

Abbreviation for Phase Alternating Line
PAL is a color TV broadcasting system developed by Telefunken GmbH of Germany. This system is adopted mainly in European countries, in Australia, and in parts of Asia and South America.

PLUGE signal

PLUGE is an abbreviation for Picture Line Up Generating Equipment.
The PLUGE signal superimposed onto a SMPTE color-bar signal is used as a reference signal for the black-level adjustment.

progressive

For a CRT monitor, it means a sequential scanning that scans an odd-numbered line to an even-numbered line in sequence without performing an interlace scanning.
For an LCD monitor, it means a simultaneous display on the entire screen by writing information to the TFT on every picture element simultaneously using the driver.

purity

The color purity of a CRT. Good purity means that there are no mixture of colors when reproducing just an R, G, or B signal over the entire screen. Purity can be affected by factors such as horizontal discrepancy of the electron gun and thermal expansion of the shadow mask (doming). There is no mixture of colors with an LCD, because it has separated R, G, and B color filters achieved by precision mounting technology. However, with the technology employing white backlight, the color purity somewhat decreases because the color filters cannot completely separate the wavelength of R, G and B signals on the backlight source. To improve the color purity, an LED backlight source in which RGB components are completely separated and have a sharp wavelength for each is under development.

S

SECAM

Abbreviation for Sequentiel Couleurs A Memoire
The color TV broadcasting system developed in France. This system is used in France, Russia, and eastern European countries.

setup level

A black signal level defined as the reference for a video signal. The standard setup level of NTSC signal is 7.5 IRE in North Amarica and 0 IRE in Japan.

SMPTE

Abbreviation for Society of Motion Picture and Television Engineers (U.S.A.)

T

trap filter

A circuit that separates the composite video signal into luminance and chrominance signals (Y/C separation). The luminance can be separated from the composite signal by removing the high-frequency component centering around the chroma subcarrier (PAL: 4.43 MHz, NTSC: 3.58 MHz). This circuit is relatively simple, and the luminance signal can be output without any peripheral circuitry. However, because the high-frequency component of the luminance signal is removed, detail in the luminance signal is lost, resulting in a deterioration of horizontal resolution. This shortcoming is overcome by the introduction of a comb filter.

U

underscan

A function that enables the entire video signal to be viewed on the display by reducing the scanning area of the CRT. When normal display mode is selected, the electron beam scans a wider display area (about 110%) than the effective display area, which is referred to as normal scan. If underscan is selected, the scanning area, and in turn the display size for a given video signal, is reduced. This enables the entire video signal to be displayed. This function is used to check the edges of the viewing area during camera recording and editing.

uniformity

The uniformity of white color reproduction
Even though purity may be optimized, perfect uniformity may not be obtained. This is due to thickness variations of the phosphor coating that occur during CRT production. Production control for high-resolution CRTs is especially difficult. The uniformity degradation on an LCD is due to thickness variations of color filters and inaccurate orientation of liquid crystal that occur during production, as well as due to the

design of the optical system such as a diffusion panel and back light. Design and production control for large-size and thin LCD devices are especially difficult.

Index

SONY

The Basics of Monitor Technology

http://www.sony.net/